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White hake (Urophycis tenuis) from the southern Gulf of St. Lawrence: a review of the fishery in 1990 and 1991

by

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ABSTRACT

Since 1970, nominal landings have varied from a minimum of 3,616 t in 1974 to a maximum of 14,039 t in 1981. The provisional nominal landings for 1990 and 1991 (4,919 t and 4,106 t respectively) were below the average (6,380 t) for the period 1970-91. The proportion of the landings taken by gillnetters continued to be greatest in 1990 and 1991 but landings by this gear type have been below average since 1985. Eighty to 90% of the total landings since 1986 have come from unit areas 4Tg, 4Tj and 4Tl (depths < 200m). As in previous years, the majority of the landings in 1990 and 1991 were taken in July and August. The TAC has been 5,500 t, since 1988.

The modal age has shifted from age 6 in 1988 and 1989 to age 5 in 1990 and 1991. Since 1986, fewer older fish (age 8-10) have been caught. The fishery is dependent on only 4 year classes and as a result it will be sensitive to annual fluctuations in recruitment.

The research vessel mean catch per tow decreased in 1990 and 1991 and there were fewer 1, 3 and 4 year old's caught than in 1989. The indication is that recruitment is not above average. The mean length and weight of white hake caught during the surveys in 1990 and 1991 were lower than those seen from 1986-88. The estimates of population abundance and biomass for 1990 and 1991 are below average for the series of Lady Hammond surveys of the southern Gulf (1986-91).

An SPA based assessment of this resource has not been conducted since 1989 due to the lack of a reliable index of abundance and because of concerns about stock definition. Instantaneous mortality rates (Paloheimo Z's), calculated from research surveys indicate that the fishing mortality appears to have been high (approximately 1.0) for the past several years.

Anecdotal reports from the Index Fishermen Program suggest that hake tended to be "smaller and scarcer" in 1990 and 1991.

RÉSUMÉ

Depuis 1970, les prises nominales ont varié, passant de 3616 t en 1974 à 14039 t en 1981. D'après les chiffres provisoires obtenus, les prises nominales de 1990 et de 1991 (4919 t et 4106 t respectivement) étaient inférieures à la moyenne (6380 t) de la période allant de 1970 à 1991. Une grande partie de ce manque peut être imputée à la baisse des prises par le secteur de la pêche aux filets maillants. De quatre-vingt à quatre-vingt-dix pour cent des prises totales réalisées depuis 1986 provenaient des sous-divisions 4Tg, 4Tj et 4Tl (à des profondeurs inférieures à 200 m). Comme par le passé, la majorité des débarquements ont eu lieu en juillet et août. Le TPA est fixé à 5500 t depuis 1988.

En 1988 et 1989, le groupe d'âge modal était celui de 6 ans; il est passé à 5 ans en 1990 et 1991. La pêche est devenue de plus en plus axée sur 3 ou 4 classes uniquement (5 à 7 ans).

La moyenne des prises par trait de chalut réalisés par le navire de recherche a baissé en 1990 et 1991, et on a capturé moins de poissons de 1 an, 3 ans et 4 ans qu'en 1989. Cette situation indique que le recrutement n'est pas supérieur à la moyenne. La longueur et le poids moyens des merluches blanches capturées pendant les relevés de 1990 et 1991 étaient inférieurs aux moyennes obtenues au cours des relevés de 1986 à 1988. Les estimations de la biomasse et de l'effectif de la population pour 1990 et 1991 sont également inférieures à la moyenne pour la série de relevés effectués par le navire Lady Hammond dans le sud du golfe (de 1986 à 1991).

Il n'y a eu aucune analyse séquentielle de la population (ASP) de cette ressource depuis 1989, à cause de l'absence d'un indice d'abondance fiable et à cause aussi des inquiétudes à l'égard de la définition du stock. Les taux de mortalité instantanée (Paloheimo Z), calculés à partir des relevés de recherche, indiquent que la mortalité due à la pêche semble avoir été élevée (environ 1,0) depuis quelques années.

D'après les déclarations obtenues des pêcheurs repères au poisson de fond, on suppose que le merlu a tendance à être plus petit et plus rare en 1990 et 1991.

INTRODUCTION

The fishery for white hake (Urophycis tenuis, Mitchill) in the southern Gulf of St. Lawrence usually does not commence until May when the last of the sea ice has dispersed. Landings peak between July and September and decline through October and November (Table 1a and b). Since 1970, nominal landings have ranged from a low of 3,616 tonnes in 1974 to a high of 14,039 tonnes in 1981 (Table 2 and Figure 1). This resource was not managed by a TAC (Total Allowable Catch) until the precautionary quota of 12,000 tonnes was placed upon this stock in 1981 for the 1982 season. Recent assessments (Clay et al., 1986; Clay, 1987; Clay and Hurlbut, 1988) suggested long term yields in the range of 5,000 to 6,000 tonnes. The TAC for 1987 was reduced to 9,400 tonnes and for 1988 to 5,500 tonnes. It has remained at 5,500 tonnes since then.

This fishery is carried out mainly by small inshore vessels, and is strongly affected by weather and local market conditions. Winter ice conditions preclude inshore fishing from December through April of most years. Two gear types are used in this fishery: fixed gear (gillnets and longlines); and mobile gear (small otter trawlers (< 20m) and larger seiners). The majority of the fishery is conducted in Northumberland Strait, on the western end of P.E.I., and between P.E.I. and Cape Breton Island.

Previously the hake fishery in the Gulf was considered to be a by-catch fishery, however a recent analysis (Clay and Hurlbut, 1990) indicated that it tends to be a directed fishery, traditionally pursued during periods between other, more economically lucrative fisheries (ie. lobster, scallop, etc.). From 1986 to 1989 the directed portion of the Gulf hake fishery was 69 to 75% of the total landings and 44 to 48% of the total effort (trips with some hake landed)(Clay and Hurlbut, 1990). The directed fishery is most intense from June to October with gillnets having the highest percentage of directed trips in all months except September.

The combined evidence from a discriminant function analysis of morphometric and meristic characters (Hurlbut and Clay, 1990), seasonal and annual distributional studies (Clay, 1991; Clay and Hurlbut, 1989) and a tagging study (Kohler, 1971) indicate that white hake from NAFO Division 4T may be characterized by two distinct components:

(1) fish from the shallow inshore southern Gulf (depths <= 200 m), principally the Northumberland Strait area (the "Strait" component - Figure 2) and

(2) fish from along the Laurentian Channel in depths in excess of 200 m (the "Channel" component - Figure 2).

In terms of the assessment of this resource, several problems need to be addressed, including:

a) the management unit for white hake in NAFO Division 4T is composed of at least two different stock components with minor biological differences,

b) the research vessel data for these two components are limited and highly variable, and thus of little use in assessment calibration,

c) there are difficulties with the interpretation of trends in commercial catch rate series derived from purchase slips (trip effort) and

d) the white hake fishery often comprises an 'alternate fishery' rather than a 'by-catch fishery'.

Because of these problems, a formal analytical assessment of this resource is difficult. The present document reviews the status of the fishery as well as other information.

LANDINGS

Total Landings in NAFO Division 4T

The provisional landings in 1990 (Table 1a - Figure 1) were 4,919 tonnes, a decrease of 4% from the 5,128 tonnes caught in 1989, and a difference of -21% from the average landings for the period: 1970-91 (Table 2). In 1991, the provisional landings were 4,106 tonnes (Table 1b - Figure 1), a decrease of 20% from 1989 and a difference of -34% from the average landings for the period: 1970-91 (Table 2).

Landings by Canadian Statistical Unit Area

In the Gulf of St. Lawrence, white hake are caught mainly by small inshore vessels that are not required to complete log books. Therefore, no estimate of fishing effort by individual vessels is available. Trip landings are, however, recorded on purchase slips for the inshore as well as other components of the fishing fleet. These generally only include 75% to 95% of the official landings. The rest of the landings are reported on Supplemental 'A' and 'B' slips.

Eighty to 90% of the total white hake landings in the past six years have come from that part of the 'Strait' component of the NAFO Division 4T management unit comprising Unit areas 4Tg,

4Tj, and 4Tl (Figures 3 and 4). Over the same period (1986-91), annual landings from the unit areas that encompass the 'Channel' component (ie. > 200 m depth) (Unit areas 4Tf, 4Tk, and 4To) have not exceeded 10% of the total landings, however, these unit areas also include some inshore shallow zones that probably produced the majority of the reported landings in these areas. Landings from unit areas 4Th and 4Tm have been minor and constant, while landings from unit area 4Tn have increased since 1988 (Table 3 - Figure 5). Thus, since 1986, the majority (approximately 90%) of the hake landings in the Gulf of St. Lawrence have been from the 'Strait' component of the stock.

Landings by Gear Type

The gillnetter portion of the landings was still the largest in 1990 and 1991, however, the proportion of the landings attributable to this component has decreased (from 36% in 1989 to 28% in 1991) and was only marginally greater than the otter trawl portion (27%) in 1991 (Tables 1 a and b - Figure 6). Landings by longliners and seiners were not substantially different than in 1989.

Commercial catch rates

A commercial catch rate series has been used in past assessments of this resource, when it was assumed that each purchase slip represented one unit of fishing effort (day). This approach was not employed this year because the model explained only a small percentage (< 25%) of the variation in previous years and because of errors encountered in the coding of inshore otter trawlers (Prior to 1984 a certain percentage of the stern trawlers were coded as side trawlers and vice versa).

As a long term solution to this problem, an Index Fishermen Program has been started in the southern Gulf of St. Lawrence. It is directed at cod in particular but is designed to collect data for other species as well. Of the 50 participants in this program, about one quarter are considered to fish at least part-time for white hake.

AGE DETERMINATION AND COMMERCIAL SAMPLING

In 1990 and 1991, all of the commercial white hake samples from NAFO Division 4T came from fish caught in less than 200 m depth ('Strait' component of the stock). No samples came from Unit Areas 4Tf, 4Tk, or 4To (areas incorporating the 200 m contour) (Figure 3).

Commercial port samples of white hake were obtained according to previously established protocols (Clay et al., 1985; Clay and Hurlbut, 1989; Clay and Clay, 1991). Samples were obtained from 2 sources:

1) the P.E.I. Department of Fisheries and Labour provided 9 length frequency samples (1,523 fish measured) in 1991

2) In 1990, the Department of Fisheries and Oceans (DFO) port samplers collected 40 length frequency samples (6,697 fish measured) and 799 otoliths, of which 738 provided acceptable age estimates. In 1991, DFO port samplers collected 34 length frequency samples (6,458 fish measured) and 569 otoliths, of which 541 provided acceptable age estimates.

The commercial port samples and research vessel surveys (741 otolith ages in 1990 and 821 otolith ages in 1991) provided the material for estimates of growth.

After the age of about 3, white hake are sexually dimorphic; females grow faster, to a larger size, and to an older age than males (Clay and Clay, 1991). The protocol on research surveys was changed to permit sexed sampling (length frequencies and otoliths) but low commercial sampling intensity and the tendency for white hake to be landed gutted/head-off have precluded the construction of separate commercial age-length keys for each sex.

The age composition for the research surveys (1990 and 1991), were calculated from sexes combined and sexes separated keys to investigate the impact of not obtaining sexed commercial samples. This analysis indicates that the impact appears to be minimal for both years (1990 and 1991 - Figure 7).

Quality control tests were conducted during the entire period of age determination, after every 200 to 250 otoliths. In 1990, intra-reader agreement ranged from 80 to 91% with a mean of 84% when repeat samples were re-aged. In 1991, intra-reader agreement ranged from 78 to 91% with a mean of 85%. Agreement with the past control (contract) reader in 1990, ranged from 75 to 84% with a mean of 80% when reference trays (50 previously aged otoliths) were re-aged. In 1991, agreement with the past control reader ranged from 67 to 83% with a mean of 77%.

Low sampling intensity in 1990 and 1991 allowed for separation of aged samples into only two gear groupings for both years (Table 4 a and b). As with previous assessments of this resource, otter trawls and seines were combined because they were considered comparable as were gillnets and longlines.

Seven combinations of time and gear were chosen for the length frequency data from the available samples for 1990 and 1991 (Tables 4 a and b). The appropriate age-at-length keys were

used to determine the age composition of the length frequencies from the landings.

The catch-at-age, weight-at-age and length-at-age were calculated for each key for 1990 and 1991 (Tables 5, 6 and 7 a and b respectively) using the AGELEN program (ver 3.21) for sexes combined. These data were added together for the final catch numbers at age and a weighted average (by numbers in each age group) was calculated for the weights- and lengths-at-age.

The mean length-at-age in 1990 and 1991 (Table 7 a and b) was compared with the mean length-at-age for 1988 and 1989 (Table 7 c and d). As in the past, larger fish were predominant in the gillnet landings, however the mean length- and weight-at-age of fish caught by longline was considerably smaller, and more similar to the mean length-/weight-at-age for the two mobile gears. This apparent similarity in length- and weight-at-age must be due, in part, to the limited number of samples from this gear component.

When the catch-at-age for 1990 and 1991 is compared with that for 1988 and 1989 (Table 8 and Figure 8), it is evident that fewer older fish (ie. age 8-10) have been caught since 1986. The modal age has shifted from age 6 in 1988 and 1989 to age 5 in 1990 and 1991. One- and two-year-olds, which occurred for the first time in the commercial samples in 1989, were absent in 1990 and 1991. This fishery is dependent on only 4 year-classes (ages 4 - 7) and, as a result, it will be sensitive to annual fluctuations in recruitment.

RESOURCE SURVEY DATA

The annual September resource survey in the southern Gulf of St. Lawrence in 1990 and 1991 was a random stratified, 24 hour survey (147 and 192 sets completed).

In previous analyses, the RV abundance has not been successfully used in the calibration of the assessment for this resource.

For this update, the research vessel mean catch per tow, C.V.'s of the mean catch per tow, and weights-at-age (Tables 9 a,b and c) were estimated using the RVAN analysis programs. From 1971-83, the survey of the southern Gulf was a stratified random survey (E.E. Prince), but approximately twelve fixed stations were surveyed each year. These fixed stations were included in this analysis, as they were in previous assessments (Clay and Hurlbut, 1989, 1990). For the years 1984 - 1987, when the survey of the southern Gulf was a fixed station design (Lady Hammond), the dataset for this analysis was limited to only 61 fixed

stations that were fished each of the four years as was done for the assessment of 4TVn (Jan.- April) cod (Chouinard and Sinclair, 1988). Since 1988 the survey has been a stratified random survey.

The research vessel mean catch per tow decreased in 1990 and 1991 (Figure 9 - Note: the catch rate for the E.E. Prince was adjusted with the conversion factor (1.2) derived from a comparative fishing experiment conducted in 1985 (Nielsen, 1987)) and there were fewer 1, 3 and 4 year olds caught than in 1989 (Table 9a). The indication is that recruitment is not above average. The mean length and weight of white hake caught during the surveys in 1990 and 1991 was lower than seen from 1986-88 (Figure 10). The estimates of population abundance and biomass for 1990 and 1991 are below average for the series of Lady Hammond surveys of the southern Gulf (1986-91)(Table 10).

An SPA based assessment of this resource has not been conducted since 1989 due to the lack of a reliable index of abundance and because of concerns about stock definition within the 4T management unit.

Instantaneous mortality rates were calculated for white hake caught on research vessel surveys (1971 - 91) using Paloheimo's (1961) method (Table 11):

$$Z = -\ln [(C/f)_2/(C/f)_1]$$

(where $(C/f)_n$ = mean catch per tow at age)

This analysis indicates that the fishing mortality appears to have been high (approx. 1.0) for the past several years.

ANCILLARY INFORMATION

At industry meetings, in 1988 and 1989, fishermen in Northumberland Strait (eastern PEI - St. Georges Bay) reported catching more small hake than in recent years. In 1990 and 1991, many of the participants in the Index Fishermen Program, that directed for white hake (predominately those fishing fixed gear), reported that hake tended to be "smaller and scarcer".

SUMMARY

Landings were below average in 1990 and 1991 (21% and 34% below those for the period 1970-91). Fewer old white hake were caught and the fishery is dependent on only four age classes. As a result, this fishery will be sensitive to annual fluctuations in recruitment.

The research vessel surveys indicate that recruitment has not been above average and that fishing mortality appears to be high.

The precautionary TAC of 5,500 t appears to represent a high rate of exploitation. However, given the uncertainties about stock definition, there is no firm basis to suggest a modification of the 5,500 t TAC.

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REFERENCES

Chouinard, G.A. and A.F. Sinclair (1988). Assessment of the 4T-Vn (Jan.- Apr.) cod stock for 1988. CAFSAC Res. Doc. 88/28, 47p.

Clay,D. (1987). Assessment of Gulf white hake from NAFO division 4T in 1987 (Including an investigation of otolith size to fish length relationships). CAFSAC Res. Doc. 87/81, 57p.

Clay, D. (1991). Seasonal distribution of demersal fish (Osteichthyes) and skates (Chondrichthyes) in the southeastern Gulf of St. Lawrence.In J.-C. Therriault [ed.]. The Gulf of St. Lawrence: Small ocean or big estuary? Can. Spec. Publ. Fish. Aquat. Sci. 113p.

Clay, D. and H. Clay. (1991). Determination of age and growth of white hake (Urophycis tenuis, Mitchill) from the southern Gulf of St. Lawrence, Canada (including techniques for commercial sampling). Can. Tech. Rept. Fish. Aquat. Sci. 1828: 29 + vi p.

Clay,D., T.Hurlbut, and L.Currie. (1986). Assessment of Gulf white hake: NAFO Division 4T/1986. CAFSAC Res. Doc. 86/81, 46p.

Clay,D., T.Hurlbut, L.Currie and J. Murchison. (1985). Sampling Gulf White Hake: 1970 to 1984 in NAFO Div. 4T. CAFSAC Res. Doc. 85/65, 34p.

Clay,D. and T.Hurlbut. (1988). Assessment of Gulf white hake from NAFO division 4T in 1988. CAFSAC Res.Doc. 88/63, 46p.

Clay, D., and T. Hurlbut. (1989). Assessment of Gulf white hake from NAFO Division 4T in 1989 (Including an investigation of their distribution in the southern Gulf of St. Lawrence). CAFSAC Res. Doc. 89/52, 76p.

Clay, D., and T. Hurlbut. (1990). White hake (Urophycis tenuis) from the southern Gulf of St. Lawrence: a review of the fishery in 1989. CAFSAC Res. Doc. 90/74, 42p.

Hurlbut,T. and D.Clay. (1990). An investigation of white hake (Urophycis tenuis) population structure in the southern Gulf of St. Lawrence, NAFO Division 4T, using morphometric and meristic characters. CAFSAC Res. Doc. 90/68, 58p.

Kohler, A.C. 1971. Tagging of white hake (Urophycis tenuis) in the southern Gulf of St. Lawrence. Int. Comm. Northw. Atl. Fish., Res. Bull. 8: 21-25.

Nielsen, G.A. 1987. Results of the 1985 comparative survey between the E.E. Prince and Lady Hammond. CAFSAC Res. Doc. 87/12, 22p.

Paloheimo, J.E. 1961. Studies on estimation of mortalities. I. Comparison of a method described by Beverton and Holt and a new linear formula. J. Fish. Res. Board Can. 18: 645-662.

Table 1 a. Nominal landings (tonnes) of white hake from NAFO division 4T in 1990 by gear and month. All data are provisional statistics.

MONTH	TRAWL	SEINE	LINE	GILLNET	OTHER	TOTAL
JANUARY	0.0	0.0	0.0	0.0	0.0	0.0
FEBRUARY	0.0	0.0	0.0	0.0	0.0	0.0
MARCH	0.0	0.0	0.0	0.0	0.0	0.0
APRIL	1.3	1.9	0.6	4.2	0.0	8.0
MAY	34.5	81.8	0.8	31.2	0.2	148.5
JUNE	83.2	319.0	1.9	154.0	1.8	559.9
JULY	372.5	135.9	271.5	696.3	41.9	1518.1
AUGUST	333.8	87.3	476.5	337.9	70.5	1306.0
SEPTEMBER	225.8	32.2	95.2	260.1	30.1	643.4
OCTOBER	132.0	25.2	73.2	223.7	12.1	466.2
NOVEMBER	54.1	136.3	47.2	30.2	0.0	267.8
DECEMBER	0.0	0.6	0.5	0.0	0.0	1.1
TOTAL	**1237.2**	**820.2**	**967.4**	**1737.6**	**156.6**	**4919.0**
PERCENT	**25.2**	**16.7**	**19.7**	**35.3**	**3.2**	**100.0**

Table 1 b. Nominal landings (tonnes) of white hake from NAFO division 4T in 1991 by gear and month. All data are provisional statistics.

MONTH	TRAWL	SEINE	LINE	GILLNET	OTHER	TOTAL
JANUARY	0.0	0.0	0.0	0.0	0.0	0.0
FEBRUARY	0.0	0.0	0.0	0.0	0.0	0.0
MARCH	0.0	0.0	0.0	0.0	0.0	0.0
APRIL	0.1	0.0	0.0	0.0	0.0	0.1
MAY	5.1	62.5	3.9	38.0	0.0	109.5
JUNE	48.3	322.0	1.3	207.5	0.3	579.4
JULY	367.7	110.4	211.9	389.0	10.7	1089.7
AUGUST	266.2	93.5	332.5	182.0	13.4	887.6
SEPTEMBER	250.7	80.0	256.9	126.0	14.9	728.5
OCTOBER	137.5	85.7	128.2	167.6	8.3	527.3
NOVEMBER	27.2	104.8	26.7	23.6	1.2	183.5
DECEMBER	0.1	0.6	0.0	0.0	0.0	0.7
TOTAL	**1102.9**	**859.5**	**961.4**	**1133.7**	**48.8**	**4106.3**
PERCENT	**26.9**	**20.9**	**23.4**	**27.6**	**1.2**	**100.0**

Table 2. Nominal landings (tonnes) of white hake from NAFO division 4T by gear and year and TAC (total allowable catch). All data from 1989 to 1991 are provisional.

YEAR	TRAWL	SEINE	LINE	GILLNET	OTHER	TOTAL	TAC
1960						2015+	
1961						5333+	
1962						7244+	
1963						6546+	
1964	(Designation of landings by gear type for years 1960-1969 was not possible					6205+	
1965	because gear types were not					4706"	
1966	differentiated for these years).					7024	
1967						6550	
1968						4260	
1969						4208	

\+ referred to as hake unspecified in NAFO statistical bulletins
" referred to as red hake in NAFO statistical bulletins

1970	1463	382	385	2149	1289	5668	
1971	1523	632	702	1622	1228	5707	
1972	1140	863	1604	1190	960	5757	
1973	2468	211	1045	1265	713	5702	
1974	1454	305	345	1100	412	3616	
1975	1576	306	324	1285	634	4125	
1976	1429	398	183	1147	601	3758	
1977	1227	408	231	1300	818	3984	
1978	1303	729	456	1829	508	4825	
1979	2826	912	479	3189	704	8110	
1980	3430	1615	832	4831	1715	12423	
1981	4733	1922	799	6174	411	14039	
1982	2885	994	1027	4625	245	9776	12000
1983	2141	906	753	2959	546	7305	12000
1984	1614	592	674	3631	81	6592	12000
1985	1639	1008	799	2480	88	6014	12000
1986	1316	676	1068	1884	4	4948	12000
1987	978	1347	1692	2200	155	6372	9400
1988	651	554	672	1923	87	3887	5500
* 1989	1120	1222	923	1838	25	5128	5500
* 1990	1237	820	967	1738	157	4919	5500
* 1991	1103	859	961	1134	49	4106	5500
			1970 to 1991				
AVERAGE	1784	803	769	2341	520	6216	
PERCENT	29	13	12	38	8		
			1991				
Percent	27	21	23	28	1		

* provisional

Table 3. Nominal landings (tonnes) of white hake from NAFO Division 4T from 1986 to 1991 by NAFO Unit area. The data for the period 1986 to 1989 do not include landings from Supplemental 'A' and 'B' forms and thus will not sum to the statistics in Table 2 . See Figures 4,5 and 6.

Statistical Unit area	1986	1987	1988	1989
4Tf - Magdalen Is.	67	361	152	351
4Tg - Souris/Cheticamp	1435	3042	1736	2252
4Th - Northumberland Str.	18	47	39	92
4Tj - North shore PEI	324	291	255	250
4Tk - Orphan Bank	5	9	8	2
4Tl - Miramichi	732	832	490	586
4Tm - Chaleur Bay	85	70	42	32
4Tn - Gaspe	103	84	65	114
4To - St. Lawrence River	0	0	0	10
4Tu - unknown	1277	742	674	1077
Total purchase slip	**4046**	**5479**	**3461**	**4769**
Nominal catch	**4948**	**6372**	**3887**	**5128**

Statistical Unit area	1990	1991	Mean 1986 - 1991
4Tf - Magdalen Is.	162	270	227
4Tg - Souris/Cheticamp	2267	2245	2163
4Th - Northumberland Str.	99	199	82
4Tj - North shore PEI	249	159	255
4Tk - Orphan Bank	27	8	10
4Tl - Miramichi	722	543	651
4Tm - Chaleur Bay	51	45	54
4Tn - Gaspe	327	193	148
4To - St. Lawrence River	0	0	2
4Tu - unknown	1015	443	871
Total purchase slip	**4919**	**4106**	
Nominal catch	**4919**	**4106**	

Table 4a. Keys selected for gear/time combinations and their groupings to produce age at length keys for 1990 with at least 300 fish ages.
Lower table shows the keys and associated landings for catch composition applied to each of these age at length keys.

KEY	FISHERY/PERIOD	TYPE	SIZE	AGE/LENGTH KEY
1	OTB:Jan.- July	Length	589	
		Age	26	
2	OTB:Aug.- Dec.	Length	1782	OTB/SNU: Jan.- Dec.
		Age	169	Lengths - 3544
3	SNU:Jan.- Dec.	Length	1173	Aged - 405
		Age	210	
4	GN:Jan.- July	Length	274	
		Age	29	
5	GN:Aug.- Dec.	Length	1062	GN/LL/MISC: Jan.- Dec.
		Age	110	Lengths - 3153
6	LL:Jan.- July	Length	68	Aged - 333
		Age	0	
7	LL:Aug.- Dec.	Length	1749	
		Age	194	

	....AL k e y.....		...LF c a t c h...		
KEY	DATE	GEAR	DATE	GEAR	TONNES
1	01/12	OTB/SNU	01/07	OTB	491.5
2	01/12	OTB/SNU	08/12	OTB	745.7
3	01/12	OTB/SNU	01/12	SNU	820.2
4	01/12	LL/GN	01/07	GN	885.7
5	01/12	LL/GN	08/12	GN	851.9
6	01/12	LL/GN	01/07	LL+Misc	318.7
7	01/12	LL/GN	08/12	LL+Misc	805.3
				Total	4919.0

Length/Weight Coefficients (sexes combined) from Cruise H219 (Sept. 1990): a = 0.005742
b = 3.058790

Table 4b. Keys selected for gear/time combinations and their groupings to produce age at length keys for 1991 with at least 200 fish ages.
Lower table shows the keys and associated landings for catch composition applied to each of these age at length keys.

KEY	FISHERY/PERIOD	TYPE	SIZE	AGE/LENGTH KEY
1	OTB:Jan.- July	Length	2554	
		Age	96	
2	OTB:Aug.- Dec.	Length	352	OTB/SNU: Jan.- Dec.
		Age	33	Lengths - 4440
3	SNU:Jan.- July	Length	770	Aged - 305
		Age	106	
4	SNU:Aug.- Dec.	Length	764	
		Age	70	
4	GN:Jan.- July	Length	1236	
		Age	145	
5	GN:Aug.- Dec.	Length	621	GN/LL/MISC: Jan.- Dec.
		Age	47	Lengths - 2018
6	LL:Jan.- Dec.	Length	161	Aged - 221
		Age	29	

	....AL k e y.....		...LF c a t c h...		
KEY	DATE	GEAR	DATE	GEAR	TONNES
1	01/12	OTB/SNU	01/07	OTB	421.2
2	01/12	OTB/SNU	08/12	OTB	681.7
3	01/12	OTB/SNU	01/07	SNU	494.9
4	01/12	OTB/SNU	08/12	SNU	364.6
5	01/12	LL/GN	01/07	GN	634.5
6	01/12	LL/GN	08/12	GN	499.2
7	01/12	LL/GN	01/12	LL+Misc	1010.2
				Total	4106.3

Length/Weight Coefficients (sexes combined) from Cruise H232 (Sept. 1991): a = 0.005416
b = 3.076274

Table 5a. Catch-at-age of white hake in NAFO division 4T as estimated from dockside sampling of the commercial fisheries in 1990. The seven keys refer to the keys of Table 4a.

White Hake: Catch-Numbers-at-Age (000's)

AGE	KEY 1	KEY 2	KEY 3	KEY 4	KEY 5	KEY 6	KEY 7	SUM	C.V.
1-2	0	0	0	0	0	0	0	0	
3	1	2	1	0	0	25	6	35	25.87
4	29	113	66	12	5	219	172	616	13.50
5	142	272	201	89	71	114	267	1156	7.14
6	135	159	168	178	168	25	111	944	5.69
7	34	34	63	120	108	2	31	392	11.10
8	3	8	16	19	19	1	9	75	9.89
9	0	2	5	2	5	0	3	17	11.77
10	0	1	2	1	1	0	2	7	14.29
11	0	0	1	0	0	0	1	2	
12	0	0	0	0	0	0	1	1	
13-14	0	0	0	0	0	0	0	0	
SUM (FROM KEYS)	344	591	523	421	377	386	603	3245	
# IN L-F	589	1782	1173	274	1062	68	1749		
# AGED	405	405	405	333	333	333	333		
MEAN AGE	5.53	5.24	5.60	6.14	6.23	4.38	5.08		

Table 5b. Catch-at-age of white hake in NAFO division 4T as estimated from dockside sampling of the commercial fisheries in 1991. The seven keys refer to the keys of Table 4b.

White Hake: Catch-Numbers-at-Age (000's)

AGE	KEY 1	KEY 2	KEY 3	KEY 4	KEY 5	KEY 6	KEY 7	SUM	C.V.
1-2	0	0	0	0	0	0	0	0	
3	1	15	2	9	0	0	0	27	21.60
4	26	178	58	125	1	0	5	393	17.78
5	74	251	119	167	22	41	300	974	10.86
6	87	138	86	61	80	103	229	784	7.25
7	52	31	49	9	129	98	88	456	9.14
8	10	2	9	1	24	14	13	73	10.70
9	2	0	3	0	6	1	2	14	14.29
10	0	1	2	0	2	0	0	5	20.00
11	0	1	1	0	0	0	0	2	
12	1	0	1	0	0	0	4	6	23.57
13-14	0	0	0	0	0	0	0	0	
SUM (FROM KEYS)	253	617	330	372	264	257	641	2734	
# IN L-F	2554	352	770	764	1236	621	161		
# AGED	305	305	305	305	221	221	221		
MEAN AGE	5.82	5.01	5.54	4.83	6.67	6.34	5.75		

Table 6a. Weight-at-age (kg) of white hake in NAFO division 4T estimated from dockside sampling of the commercial fisheries in 1990. The seven keys refer to the keys of Table 4a.

White Hake: Weight-at-Age (kg)

AGE	KEY 1	KEY 2	KEY 3	KEY 4	KEY 5	KEY 6	KEY 7	AVE.WGT.
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3	0.59	0.62	0.59	0.70	0.00	0.56	0.67	0.58
4	0.89	0.84	0.84	1.02	1.00	0.67	0.89	0.80
5	1.24	1.11	1.15	1.41	1.51	1.04	1.13	1.18
6	1.55	1.46	1.63	2.01	2.03	1.45	1.65	1.73
7	1.98	2.23	2.44	2.61	2.82	1.83	2.86	2.57
8	3.48	3.64	3.67	3.21	3.42	1.74	3.64	3.45
9	0.00	4.38	5.22	4.76	4.53	0.00	5.64	4.94
10	7.03	8.49	6.41	4.06	4.03	0.00	5.64	5.81
11	0.00	0.00	5.83	5.83	6.59	0.00	8.33	7.08
12	0.00	0.00	0.00	0.00	6.64	0.00	9.26	9.26
13	0.00	0.00	10.08	5.83	6.22	0.00	6.16	
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MEAN (FROM KEYS)	1.43	1.26	1.57	2.10	2.26	0.83*	1.34	
# IN L-F	589	1782	1173	274	1062	68	1749	
# AGED	405	405	405	333	333	333	333	
MEAN AGE	5.53	5.24	5.60	6.14	6.23	4.38*	5.08	

Table 6b. Weight-at-age (kg) of white hake in NAFO division 4T estimated from dockside sampling of the commercial fisheries in 1991. The seven keys refer to the keys of Table 4b.

White Hake: Weight-at-Age (kg)

AGE	KEY 1	KEY 2	KEY 3	KEY 4	KEY 5	KEY 6	KEY 7	AVE.WGT.
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3	0.57	0.51	0.58	0.57	0.00	0.00	0.00	0.54
4	0.86	0.80	0.83	0.79	0.65	0.00	0.80	0.80
5	1.20	1.04	1.07	0.99	1.40	1.48	1.21	1.13
6	1.59	1.39	1.52	1.29	2.12	1.82	1.54	1.59
7	2.33	2.05	2.44	1.81	2.55	2.19	2.27	2.33
8	3.16	2.54	3.17	2.94	2.84	2.34	3.26	2.90
9	5.11	0.00	4.98	0.00	3.72	3.16	3.89	4.17
10	6.19	5.95	7.71	0.00	6.89	0.00	0.00	7.03
11	6.02	5.95	5.93	0.00	0.00	0.00	0.00	5.94
12	7.11	0.00	7.23	0.00	0.00	0.00	0.00	2.39
13	6.98	0.00	10.61	0.00	8.88	0.00	10.03	
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MEAN (FROM KEYS)	1.66	1.11	1.50	0.98*	2.40	1.94	1.58	
# IN L-F	2554	352	770	764	1236	621	161	
# AGED	305	305	305	305	221	221	221	
MEAN AGE	5.82	5.01	5.54	4.83*	6.67	6.34	5.75	

Table 7a. Length-at-age (cm) of white hake in NAFO division 4T estimated from dockside sampling of the commercial fisheries in 1990. The seven keys refer to the keys of Table 4a.

White Hake: Length-at-Age (cm)

AGE	KEY 1	KEY 2	KEY 3	KEY 4	KEY 5	KEY 6	KEY 7	AVE.LT.
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3	43.42	44.23	43.56	46.00	0.00	42.70	45.31	43.28
4	49.37	48.64	48.71	51.89	51.64	44.86	49.61	47.70
5	55.23	53.19	53.81	57.63	58.93	51.89	53.53	54.19
6	59.36	58.14	60.15	64.61	64.77	58.22	60.48	61.35
7	64.03	66.47	68.61	70.35	72.13	63.00	72.39	69.80
8	77.30	78.61	78.61	74.77	76.61	62.00	77.93	76.78
9	0.00	83.69	88.24	85.96	84.65	0.00	89.90	86.67
10	96.83	104.00	94.59	81.25	80.94	0.00	90.39	90.88
11	0.00	0.00	92.00	92.00	95.74	0.00	103.32	97.66
12	0.00	0.00	0.00	0.00	96.00	0.00	107.00	107.00
13	0.00	0.00	110.00	92.00	93.94	0.00	93.65	
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MEAN (FROM KEYS)	57.41	54.85	58.31	65.03	66.56	47.77*	55.37	
# IN L-F	589	1782	1173	274	1062	68	1749	
# AGED	405	405	405	333	333	333	333	
MEAN AGE	5.53	5.24	5.60	6.14	6.23	4.38*	5.08	

Table 7b. Length-at-age (cm) of white hake in NAFO division 4T estimated from dockside sampling of the commercial fisheries in 1991. The seven keys refer to the keys of Table 4b.

White Hake: Length-at-Age (cm)

AGE	KEY 1	KEY 2	KEY 3	KEY 4	KEY 5	KEY 6	KEY 7	AVE.LT.
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3	42.76	41.26	43.11	42.95	0.00	0.00	0.00	42.02
4	48.85	47.74	48.22	47.63	44.83	0.00	48.00	47.85
5	54.35	51.97	52.45	51.13	57.13	58.23	54.67	53.28
6	59.53	57.02	58.61	55.68	65.34	62.32	58.89	59.46
7	67.15	64.41	68.19	61.97	69.50	66.26	66.63	67.35
8	74.15	69.77	74.26	73.00	71.70	67.67	74.61	72.06
9	87.40	0.00	86.63	0.00	78.57	74.90	79.85	81.48
10	93.16	92.00	99.39	0.00	96.43	0.00	0.00	96.73
11	92.30	92.00	91.89	0.00	0.00	0.00	0.00	91.95
12	97.46	0.00	97.99	0.00	0.00	0.00	0.00	32.58
13	96.88	0.00	111.00	0.00	105.00	0.00	109.00	
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MEAN (FROM KEYS)	59.36	52.40	56.95	50.79*	67.69	63.51	58.60	
# IN L-F	2554	352	770	764	1236	621	161	
# AGED	305	305	305	305	221	221	221	
MEAN AGE	5.82	5.01	5.54	4.83*	6.67	6.34	5.75	

Table 7c. Length-at-age (cm) of white hake in NAFO division 4T estimated from dockside sampling of the commercial fisheries in 1989. The eight keys refer to the keys of Table 4 in Clay and Hurlbut, 1990.

	White Hake: Length-at-Age (cm)								Weighted
Age	Key 1	Key 2	Key 3	Key 4	Key 5	Key 6	Key 7	Key 8	Ave.Lt.
1	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0
2	31.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.0
3	38.1	41.7	44.0	44.0	0.0	0.0	0.0	0.0	38.2
4	47.3	50.0	50.4	49.6	53.0	49.9	48.8	49.7	49.3
5	54.1	53.3	54.3	53.8	58.8	57.8	60.3	54.2	54.7
6	59.8	59.2	60.6	60.7	63.8	62.1	64.7	60.2	61.3
7	68.1	68.1	69.9	67.3	69.1	67.8	68.0	68.9	68.5
8	75.9	78.8	76.8	73.5	75.2	75.9	72.4	78.7	76.3
9	85.0	90.1	86.5	84.1	75.4	77.3	73.4	83.9	80.7
10	99.0	100.1	99.1	0.0	69.0	75.4	80.3	89.4	89.4
11	99.8	99.0	102.4	0.0	73.8	71.0	77.8	93.9	88.9
12	108.1	0.0	106.0	0.0	0.0	96.0	96.0	106.5	106.2
13	110.6	109.8	110.9	0.0	0.0	0.0	0.0	102.5	109.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	102.9	102.9
Mean (From Keys)	58.9	59.7	64.9	60.0	67.7	65.1	67.1	64.9	63.6
No.in LF	1940	1909	808	340	3416	1551	771	1735	
No. Aged	553	553	553	553	549	549	549	549	
Mean Age	5.73	5.81	6.39	5.89	6.77	6.50	6.75	6.48	

Table 7d. Length-at-age (cm) of white hake in NAFO division 4T estimated from dockside sampling of the commercial fisheries in 1988. The six keys refer to the keys of Table 3 in Clay and Hurlbut, 1989.

	White Hake: Length-at-Age (cm)						Weighted
Age	Key 1	Key 2	Key 3	Key 4	Key 5	Key 6	Ave.Lt.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	31.0	0.0	0.0	0.0	31.0
3	0.0	0.0	34.0	0.0	0.0	0.0	34.0
4	50.7	51.1	50.4	49.8	51.0	50.2	50.6
5	54.8	54.6	55.4	59.5	56.7	54.9	55.2
6	59.5	59.0	60.4	66.2	63.4	62.6	62.3
7	69.2	66.6	69.8	71.5	70.0	70.5	70.6
8	78.7	73.4	76.7	76.7	77.4	77.7	77.1
9	87.1	89.9	89.1	83.1	86.1	89.7	86.4
10	87.5	77.0	80.8	84.7	89.6	93.1	89.1
11	94.0	100.0	101.6	95.6	100.0	99.9	99.4
12	107.0	0.0	107.9	0.0	107.5	107.6	107.6
13	0.0	0.0	0.0	101.0	101.0	106.5	105.3
14	0.0	0.0	0.0	102.0	0.0	102.0	102.0
Mean (From Keys)	58.2	56.6	60.0	70.4	65.7	64.0	63.5
No.in LF	2362	778	1122	5339	4880	1347	
No.Aged	616	616	616	616	616	616	
Mean Age	5.6	5.4	5.8	6.8	6.3	6.2	

Table 8. Catch-at-age (1,000's) of white hake from NAFO division 4T.

	Catch-at-age: NAFO 4T hake										
Age :	70	71	72	73	74	75	76	77	78	79	80
3 :	86	84	91	80	49	56	81	86	79	90	91
4 :	708	715	633	499	250	214	298	332	354	470	452
5 :	798	798	747	664	380	390	433	471	579	833	1028
6 :	456	448	485	461	297	344	333	361	545	972	1661
7 :	373	378	403	454	313	380	291	302	345	672	1196
8 :	144	144	165	191	136	171	132	136	172	315	540
9 :	74	77	84	108	78	99	67	66	61	101	137
10 :	42	43	44	50	33	42	28	29	26	47	75
11 :	12	14	12	13	8	8	5	5	4	8	7
12 :	7	8	8	9	5	7	9	8	8	11	6
13-14 :	3	3	4	4	3	3	2	2	2	4	5

Age :	81	82	83	84	85	86	87	88	89	90	91
3 :	66	5	57	60	82	1	27	1	8	35	27
4 :	427	113	128	423	212	174	457	48	109	616	393
5 :	1075	546	595	793	572	475	1296	508	530	1156	974
6 :	1976	1136	787	862	572	479	917	642	769	944	784
7 :	1391	1104	609	523	408	322	422	479	668	392	456
8 :	604	551	398	265	262	233	159	109	214	75	73
9 :	154	149	233	158	121	79	70	17	73	17	14
10 :	94	79	71	53	54	47	16	5	11	7	5
11 :	4	21	5	20	19	23	3	2	12	2	2
12 :	1	9	4	10	31	14	2	1	5	1	6
13-14 :	8	9	1	1	7	6	1	1	5	0	0

Table 9a. Mean catch per tow (numbers) of white hake estimated from research vessel surveys in the southern Gulf of St.Lawrence (NAFO division 4T).

Mean catch per tow (Survey) White hake

E.E. Prince

Age \ Year	1978	1979	1980	1981	1982	1983	1984	1985
0	.00	.00	.00	.00	.00	.00	.03	.00
1	.06	.00	.01	.00	.03	.10	.05	.11
2	2.14	.28	.29	.50	.26	.80	.58	.96
3	1.49	2.04	.96	1.10	.61	.80	1.36	2.47
4	2.49	2.06	1.77	2.50	.97	.80	1.74	2.06
5	1.98	1.82	2.29	3.10	.77	.40	1.59	.66
6	.91	1.28	.89	2.40	.71	.30	.75	.42
7	.28	.48	.44	1.40	.31	.10	.39	.30
8	.05	.13	.21	.50	.14	.10	.25	.15
9	.02	.02	.08	.20	.02	.10	.07	.13
10	.06	.02	.10	.00	.03	.00	.10	.08
11	.00	.02	.02	.00	.00	.00	.01	.02
12	.04	.06	.01	.00	.00	.00	.02	.05
13	.00	.00	.00	.00	.00	.00	.00	.01
total	9.53	8.21	7.10	11.80	3.85	3.50	6.95	7.46

Lady Hammond

Age \ Year	1986	1987	1988	1989	1990	1991
0	.18	.00	.09	.41	.49	.08
1	.49	.06	.20	1.13	.67	.54
2	4.14	.68	1.76	2.16	2.34	2.04
3	5.05	2.55	2.87	4.26	2.54	2.86
4	8.17	2.83	3.49	2.33	1.61	1.80
5	5.14	1.66	2.74	1.44	1.62	1.27
6	1.98	.83	.85	.76	.52	.59
7	1.56	.34	.31	.21	.34	.19
8	1.14	.12	.08	.03	.07	.06
9	.46	.03	.02	.02	.02	.01
10	.06	.04	.02	.01	.00	.02
11	.17	.00	.00	.01	.00	.02
12	.09	.05	.00	.00	.00	.00
13	.24	.00	.00	.01	.00	.00
total	28.88	9.20	12.44	12.78	10.23	9.49

Table 9b. Coefficients of variation (CV's) of mean catch per tow (numbers) of white hake estimated from research vessel surveys in the southern Gulf of St.Lawrence (NAFO division 4T).

Coefficient of variation of mean catch per tow (Survey) White hake

	.....Lady Hammond.....					
Age	1986	1987	1988	1989	1990	1991
0	44.31			83.16	48.10	53.46
1	27.60	36.25	29.93	54.61	36.35	43.24
2	34.05	25.46	23.68	23.56	46.16	32.73
3	30.82	38.30	25.00	18.40	47.02	33.09
4	35.50	35.08	20.41	18.35	40.59	19.98
5	29.41	26.05	16.40	17.12	23.13	18.25
6	20.11	13.54	16.30	21.55	21.98	15.47
7	15.39	21.82	17.19	28.54	32.01	23.81
8	14.71	29.53	29.42	37.17	38.39	39.79
9	16.38	100.00	54.64	51.05	99.99	71.04
10	44.15	58.24	55.98	70.72	58.68	
11	47.41			73.34	79.67	
12	30.95	73.56				
13	69.41			73.34		
14						
15						

Table 9c. Mean weight-at-age (kg) of white hake from research vessel surveys in the southern Gulf of St.Lawrence (NAFO division 4T).

Mean weight-at-age (Survey) White hake

E.E. Prince

Age	Year 1978	1979	1980	1981	1982	1983	1984	1985
0							.229	
1	.209		.216	.070	.081	.131	.166	.101
2	.297	.338	.381	.242	.342	.318	.292	.194
3	.466	.478	.539	.464	.608	.616	.580	.334
4	1.011	.864	1.010	.873	1.024	1.100	.965	.763
5	1.567	1.456	1.408	1.327	1.338	1.837	1.496	1.246
6	1.964	1.895	1.878	1.744	1.759	2.051	2.117	1.901
7	2.327	2.272	2.499	2.110	2.194	3.057	2.693	2.440
8	4.106	3.196	2.956	2.693	2.882	3.806	3.431	3.100
9	2.456	3.219	3.288	2.990	2.787	3.872	2.870	3.725
10	2.117	2.775	5.414	3.276	2.682	5.727	6.220	3.309
11		5.201	4.129	10.906*			3.919	4.135
12	7.144	2.790	9.531	3.276			7.643	11.005*
13				9.195				8.908

Lady Hammond

Age	Year 1986	1987	1988	1989	1990	1991
0	.067		.010	.047	.028	.058
1	.158	.091	.111	.085	.065	.179
2	.237	.193	.234	.209	.213	.254
3	.453	.426	.408	.423	.350	.464
4	.775	.656	.690	.595	.634	.672
5	1.303	1.183	.976	1.027	.985	1.055
6	1.944	2.072	1.688	1.571	1.450	1.557
7	3.149	3.122	2.521	2.336	2.043	2.164
8	3.717	4.106	3.462	3.338	3.804	3.711
9	3.836	6.032	6.594	5.234	4.103	4.338
10	6.736	6.402	7.836	6.657		6.593
11	7.726			8.927		7.149
12	7.378	8.401		8.927		
13	10.304					

Table 10. Research vessel population and biomass estimates for white hake from NAFO division 4T (R/V Lady Hammond September surveys: 1986-91).

Population (*1,000)

YEAR/AGE	All Ages	3+	5+	6+
1986	55770	46477	20951	11021
1987	17764	16338	5951	2741
1988	22274	18677	7331	2299
1989	22600	16050	4387	1848
1990	18482	12155	4651	1726
1991	16781	12083	3829	1582

Biomass (t)

YEAR/AGE	All Ages	3+	5+	6+
1986	69661	67596	50946	38012
1987	17834	17570	11890	8091
1988	17781	17028	10477	5401
1989	13355	12332	6537	3845
1990	10615	9609	6155	3273
1991	11277	10182	5685	3314

Table 11. Instantaneous mortality rates (Z's) calculated using Paloheimo's (1961) method (R/V Surveys).

PALOHEIMO "Z"S

E.E. Prince

AGE	79	80	81	82	83	84	85
0							
1							-1.30
2	-1.54		-3.91		-3.28	-1.76	-2.95
3	0.05	-1.23	-1.33	-0.20	-1.12	-0.53	-1.45
4	-0.32	0.14	-0.96	0.13	-0.27	-0.78	-0.42
5	0.31	-0.11	-0.56	1.18	0.89	-0.69	0.97
6	0.44	0.72	-0.05	1.47	0.94	-0.63	1.33
7	0.64	1.07	-0.45	2.05	1.96	-0.26	0.92
8	0.77	0.83	-0.13	2.30	1.13	-0.92	0.96
9	0.92	0.49	0.05	3.22	0.34	0.36	0.65
10	0.00	-1.61		1.90		0.00	-0.13
11	1.10	0.00					1.61
12		0.69					-1.61
13							0.69
14							
15							
16							
4+/5+	0.42	0.38	-0.27	1.63	1.08	-0.57	0.99
5+/6+	0.51	0.78	-0.11	1.84	1.19	-0.46	1.01
6+/7+	0.62	0.85	-0.18	2.20	1.39	-0.34	0.76
7+/8+	0.59	0.55	0.21	2.40	0.92	-0.41	0.65

Lady Hammond

AGE	86*	87	88	89	90	91
0						
1		1.10		-2.53	-0.49	-0.10
2	-3.63	-0.33	-3.38	-2.38	-0.73	-1.11
3	-1.66	0.48	-1.44	-0.88	-0.16	-0.20
4	-1.20	0.58	-0.31	0.21	0.97	0.34
5	-0.91	1.59	0.03	0.89	0.36	0.24
6	-1.10	1.82	0.67	1.28	1.02	1.01
7	-1.31	1.76	0.98	1.40	0.80	1.01
8	-1.34	2.56	1.45	2.34	1.10	1.73
9	-1.12	3.64	1.79	1.39	0.41	1.95
10	0.77	2.44	0.41	0.69		0.00
11	-0.75			0.69		
12	-1.50	1.22				
13	-1.57					
14						
15						
16						
4+/5+	-1.03	1.82	0.38	1.10	0.63	0.66
5+/6+	-1.14	2.04	0.87	1.34	0.96	1.06
6+/7+	-1.17	2.29	1.19	1.48	0.89	1.15
7+/8+	-1.07	2.74	1.58	1.68	1.17	1.36

* - **Note**: Z's for this survey may be unrepresentative because they were calculated from Lady Hammond/E.E. Prince mean catch/tow estimates.

Figure 1. Nominal landings by year (from 1960) and TAC (total allowable catch) of white hake from NAFO Division 4T.

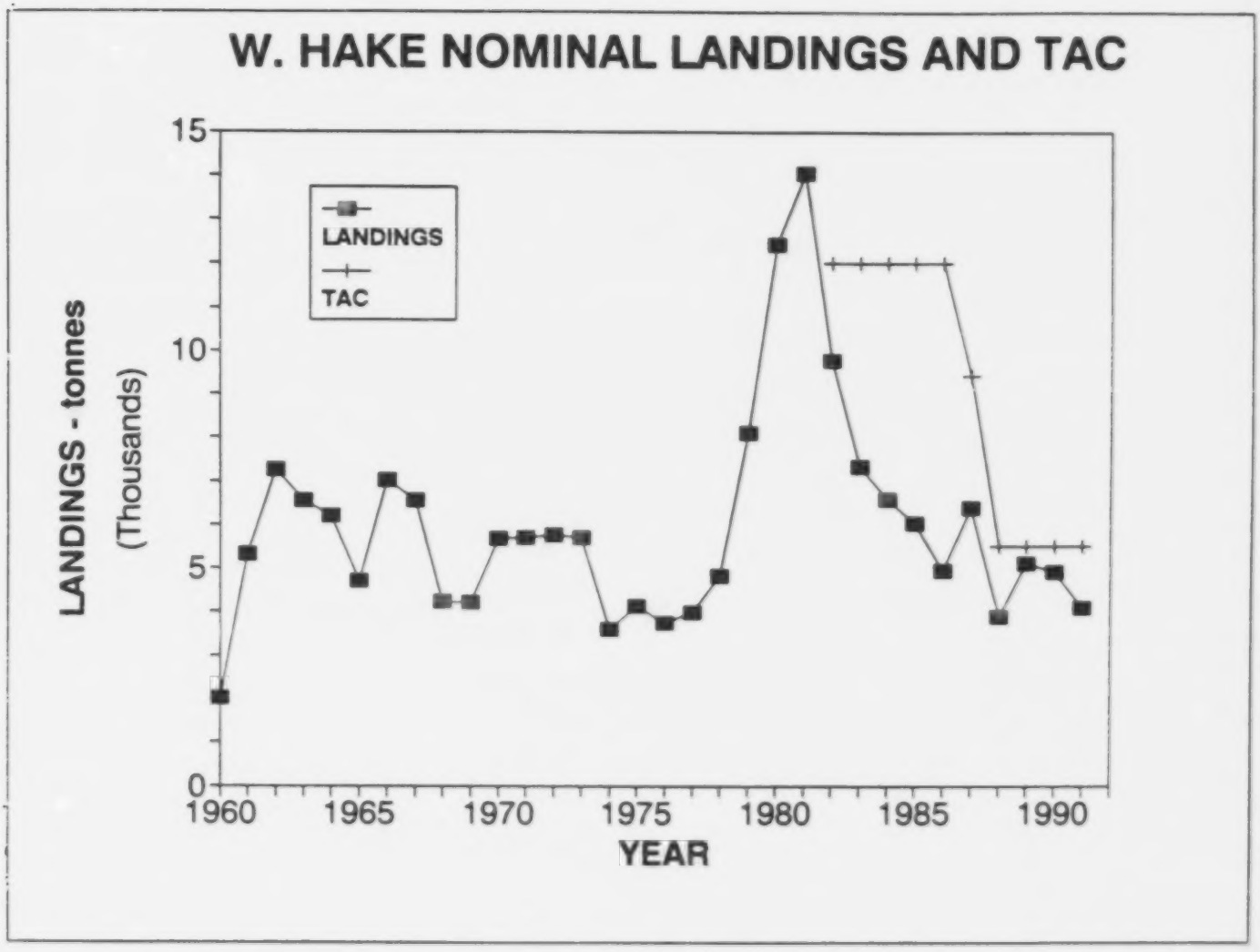


Figure 2. Strata used in the annual September resource survey of the southern Gulf of St. Lawrence (NAFO Div. 4T). Strata 415, 425, and 439 comprise the portion of the survey area over 200 m deep (the "Channel" component). All of the remaining strata (< 200 m deep) comprise what has been referred to as the "Strait" component.

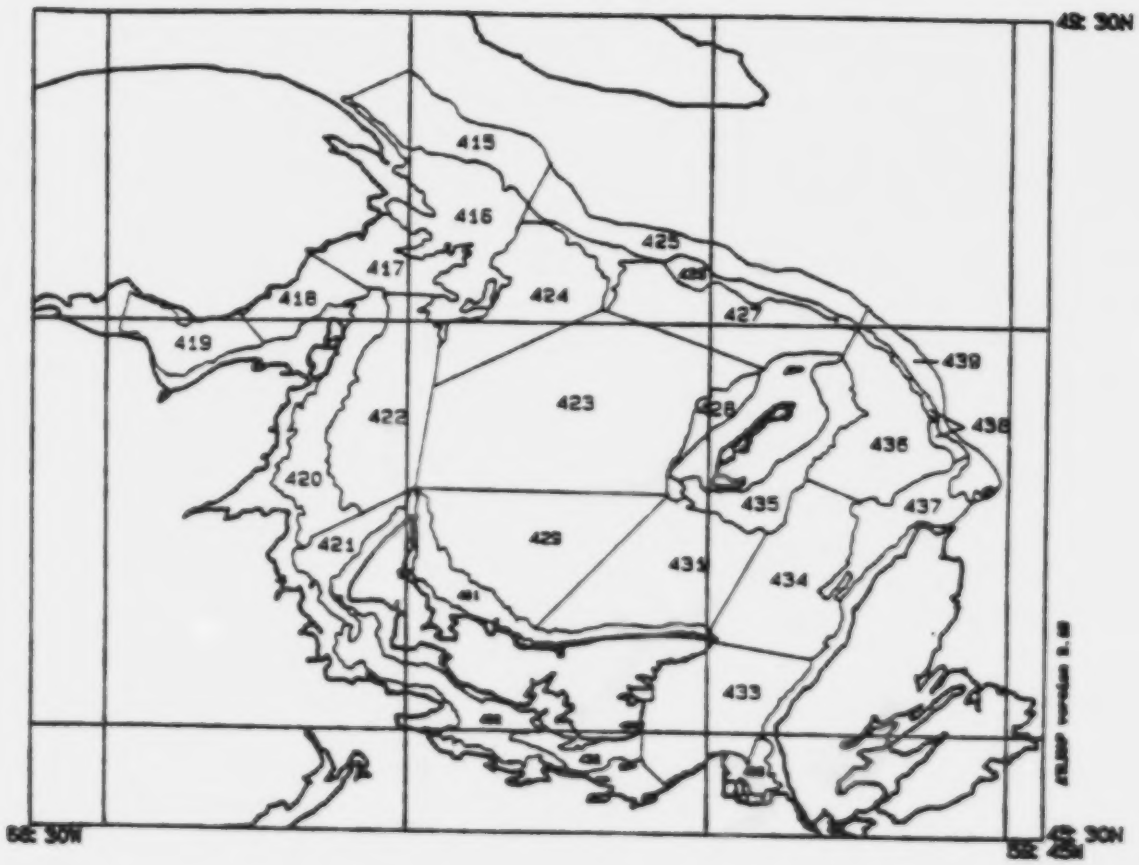


Figure 3. Canadian Statistical Unit areas (alpha and numeric codes - with "bold" borders) and associated survey strata (unlabeled (see Figure 2) - "thin" borders) for the southern Gulf of St. Lawrence.

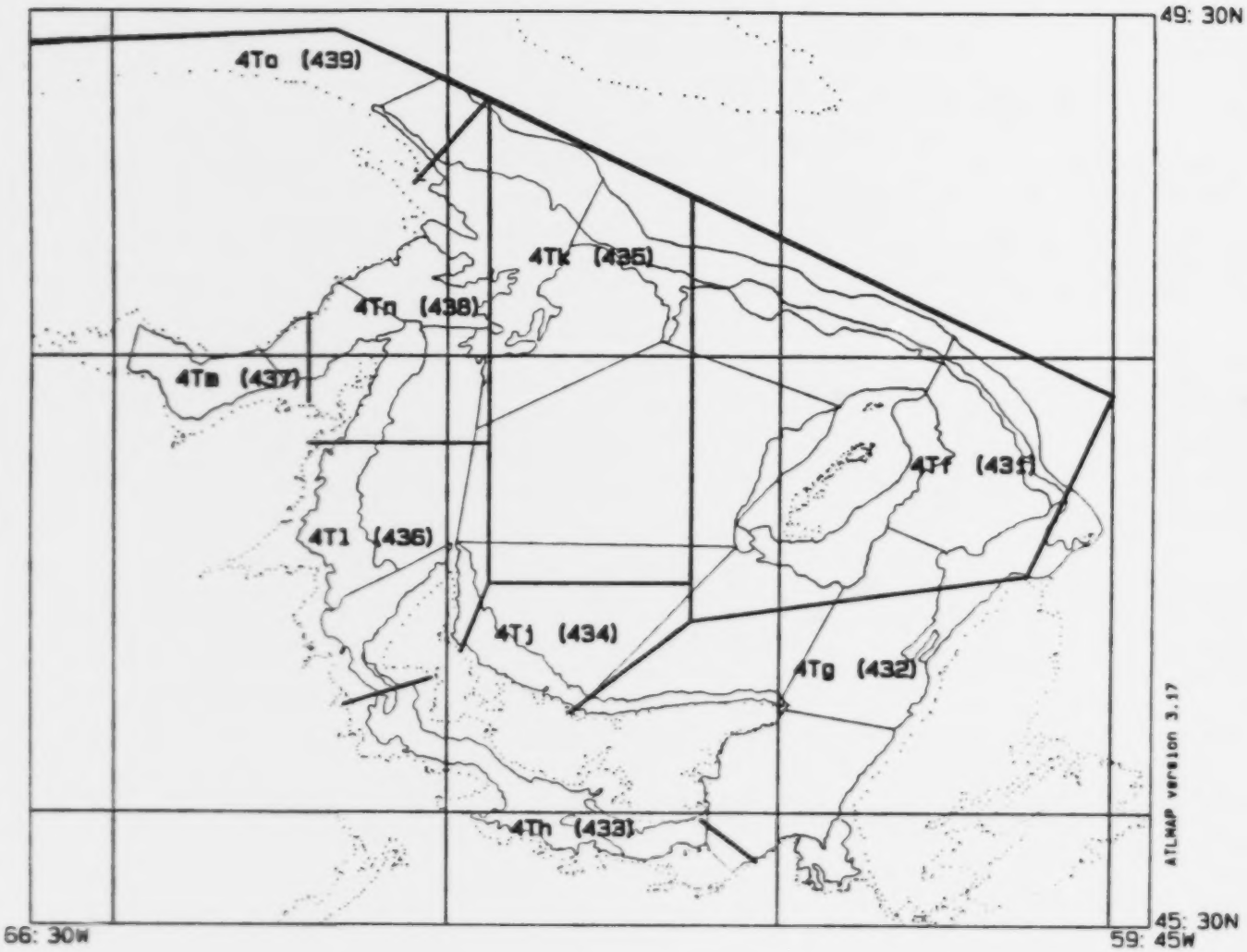


Figure 4. White hake landings (percentages) by Canadian Statistical Unit area (1986-91).

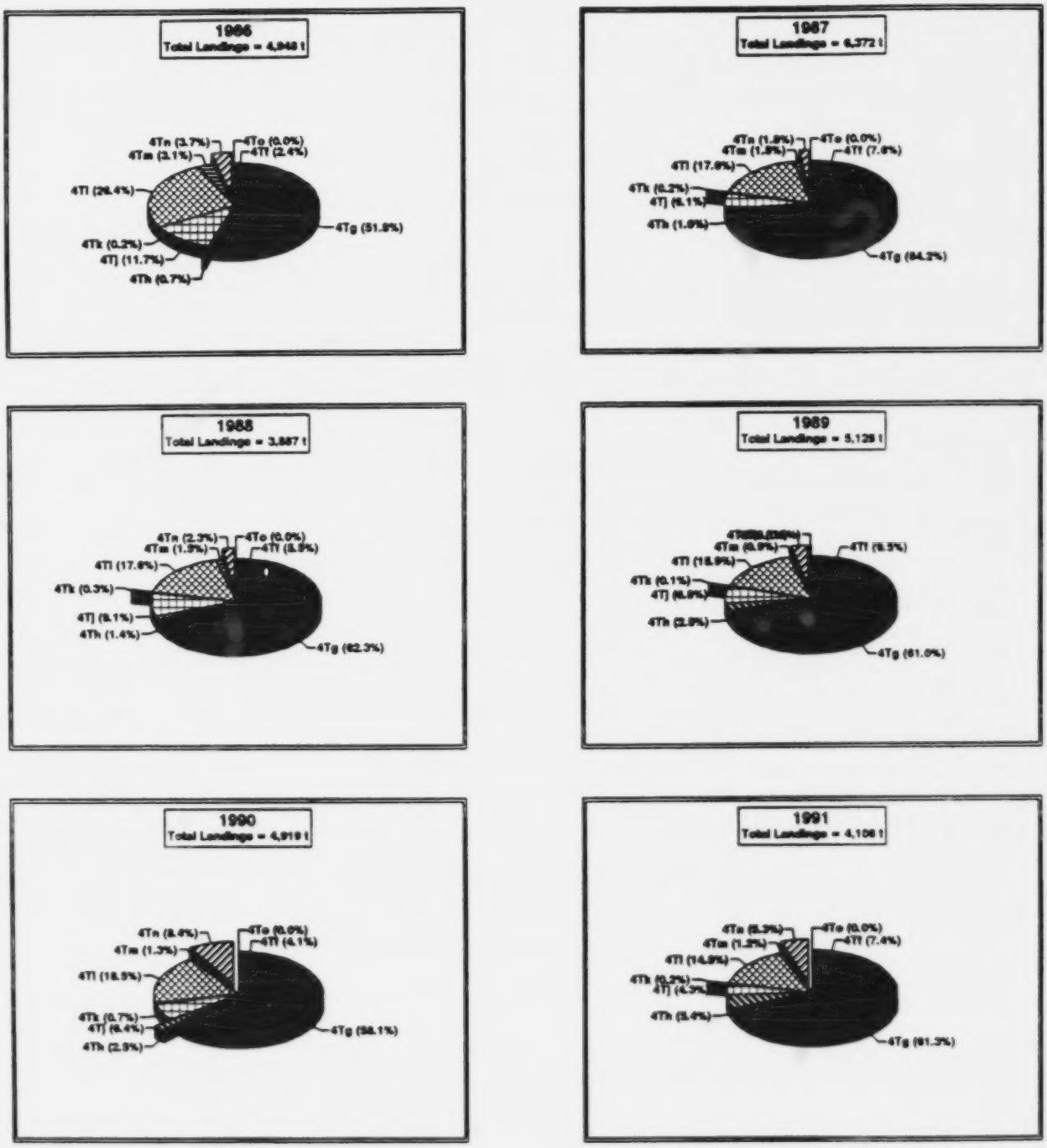
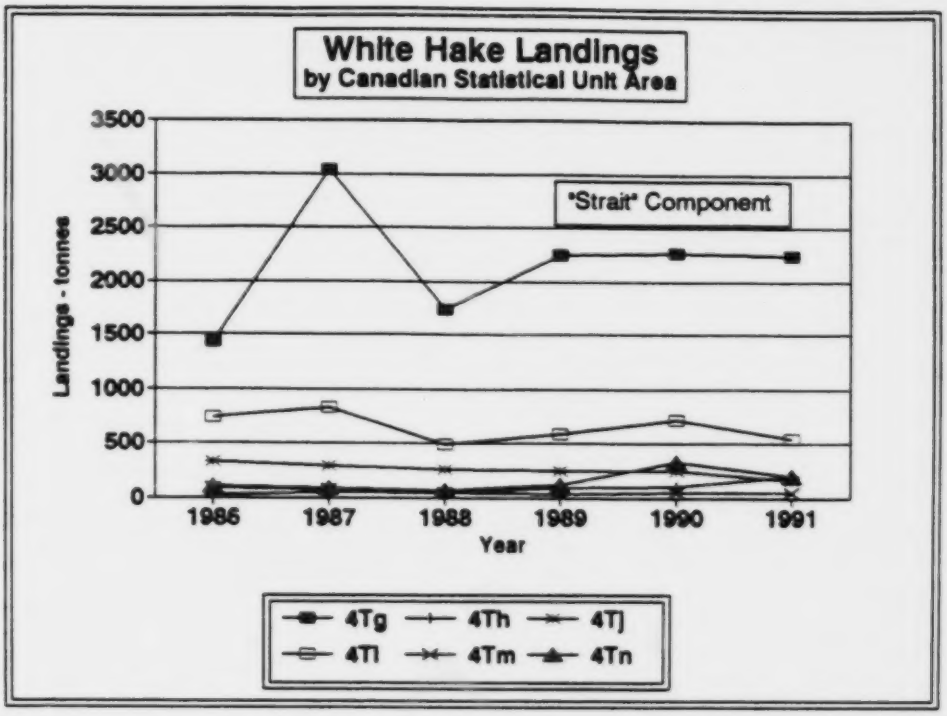


Figure 5. White hake landings by Canadian Statistical Unit area (1986-91).



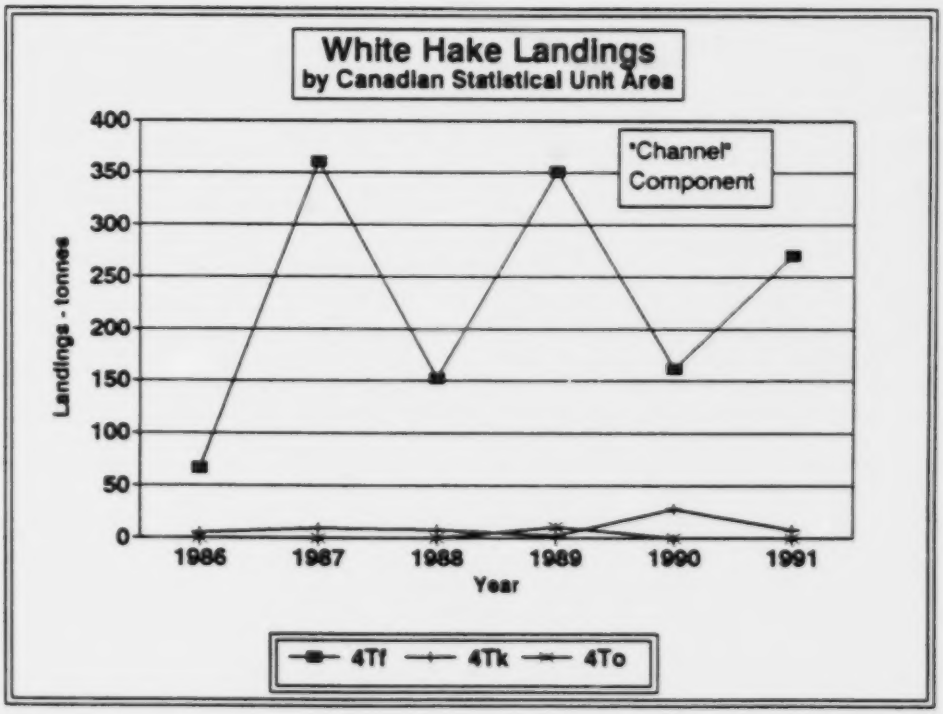


Figure 6. Nominal landings by gear and year (from 1970) of white hake from NAFO Division 4T.

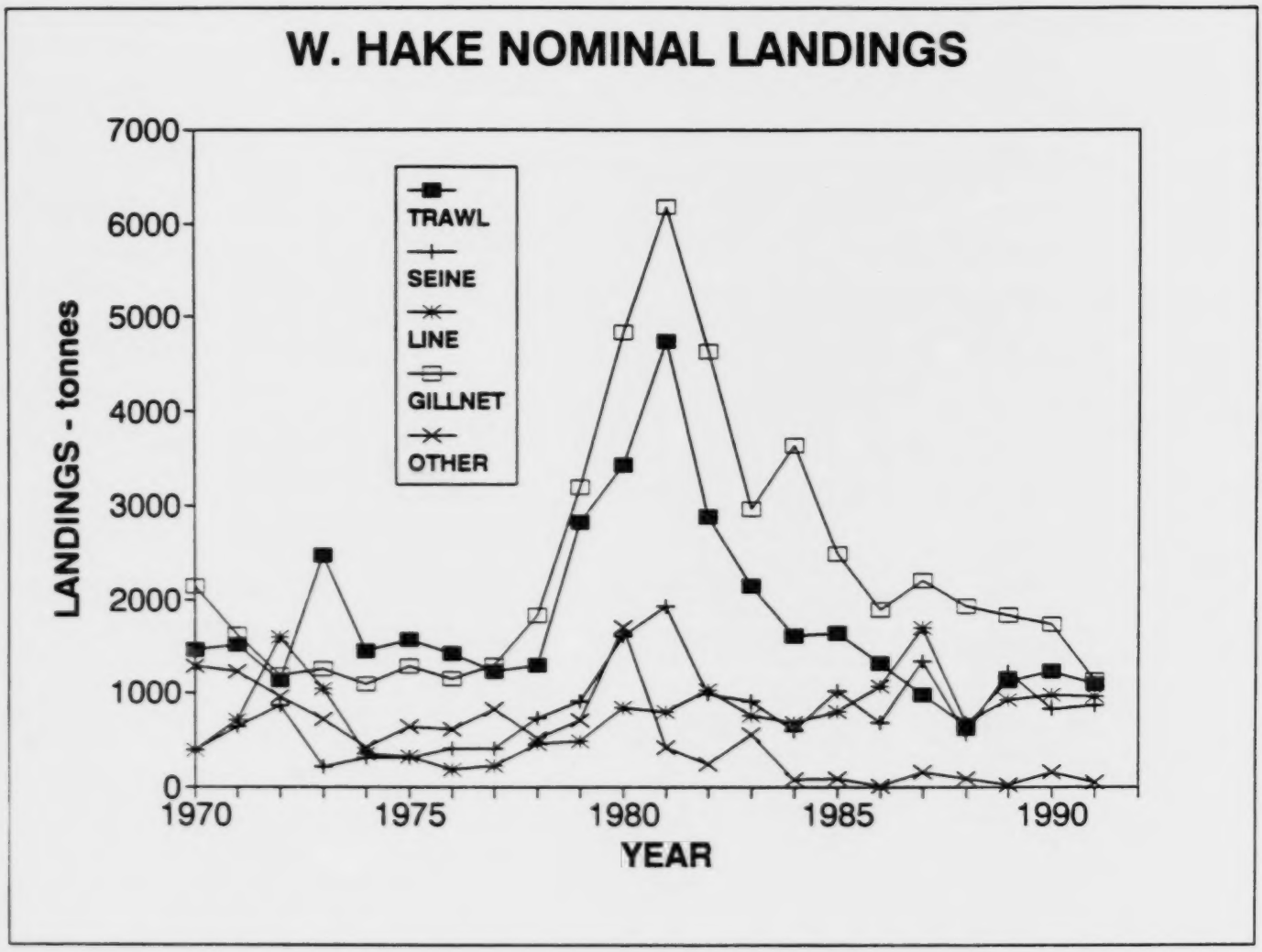
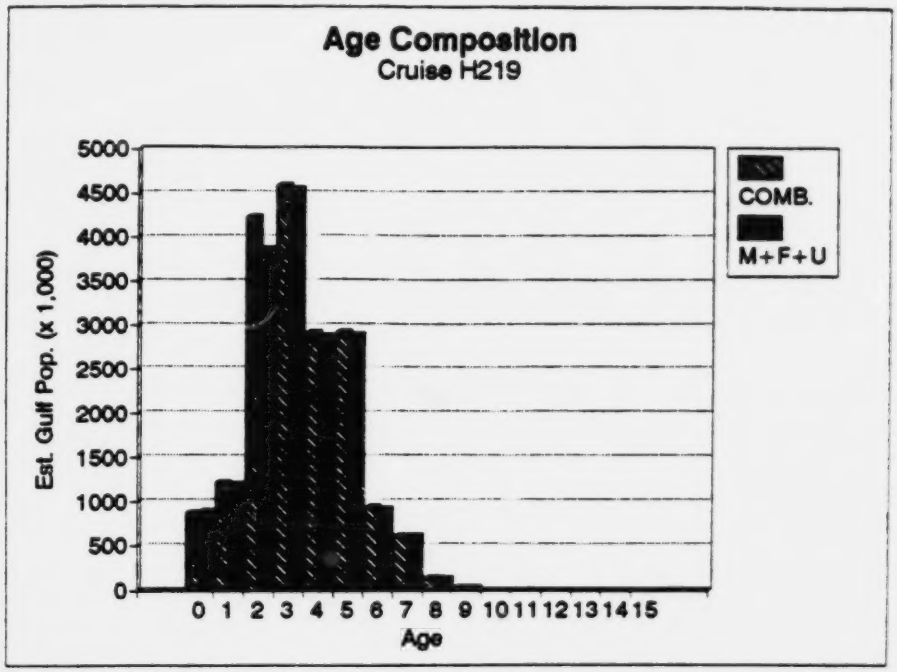


Figure 7. Age composition of white hake caught during research vessel surveys H219 (1990) and H232 (1991).



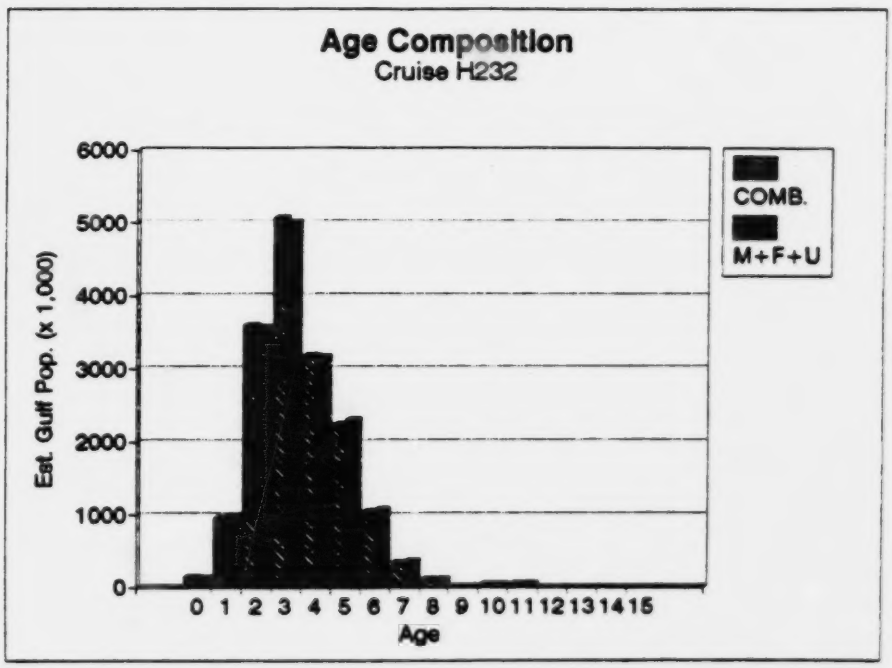
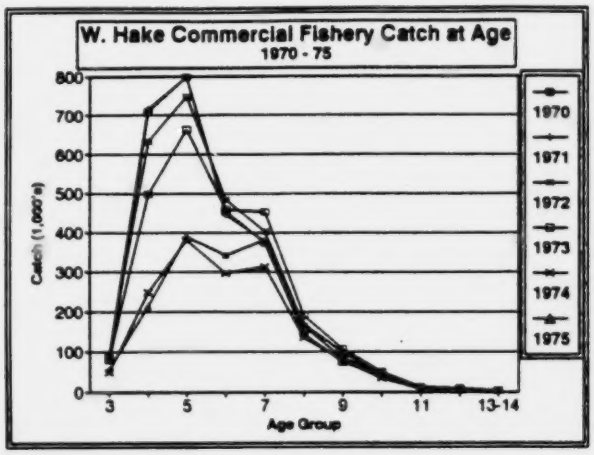
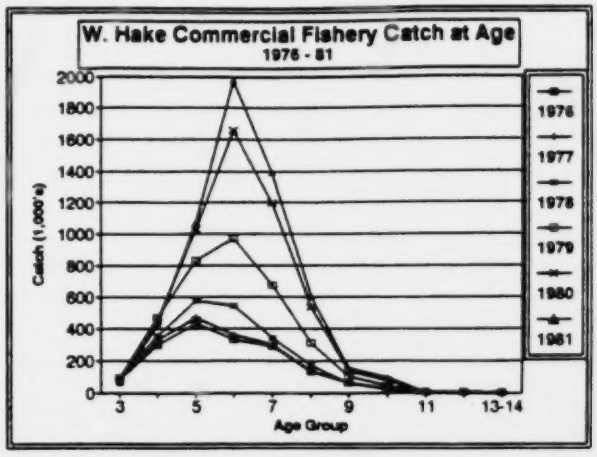
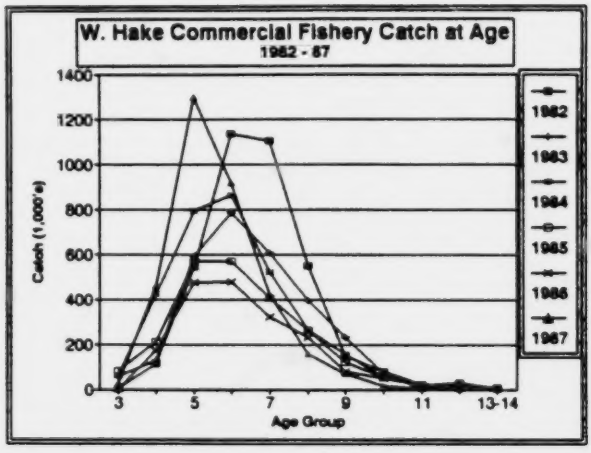
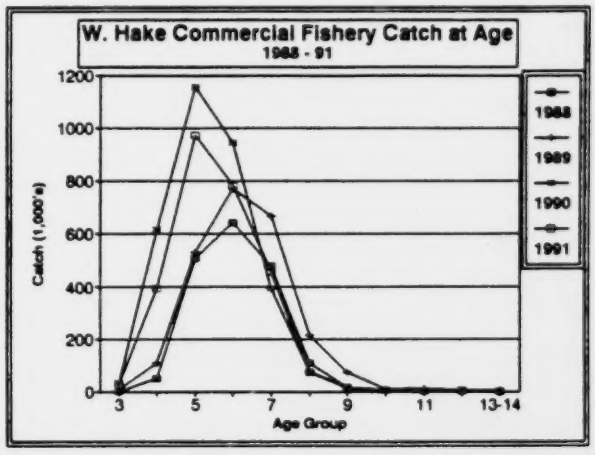


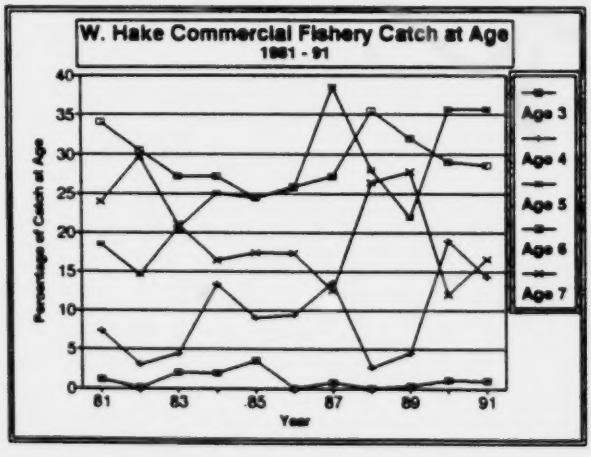
Figure 8. White hake commercial catch-at-age (1970-75), (1976-81), (1982-87) and (1988-91). The two bottom figures represent the age composition (percentage) of the landings for: 1981-91.











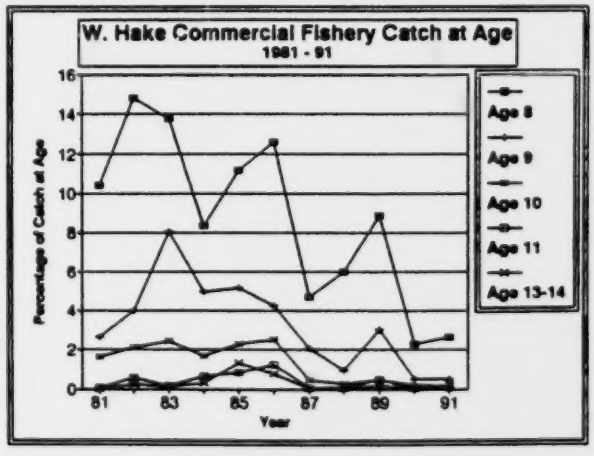


Figure 9. Mean catch per standard tow of white hake in NAFO division 4T (1971-91).

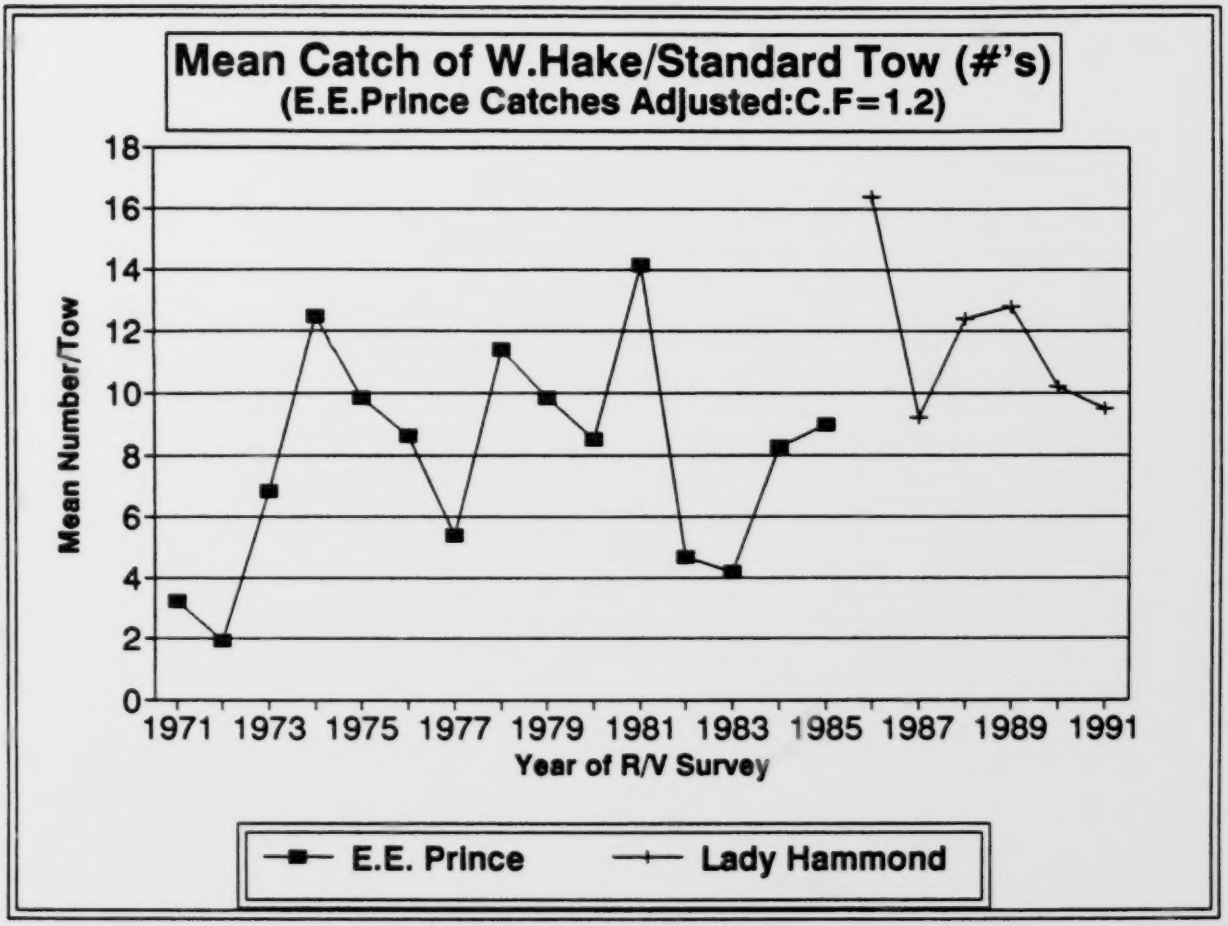


Figure 10. Mean length and weight of white hake caught during research vessel surveys of NAFO division 4T (1971-91).